


# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference M04-F-188CT1	<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA416
International application No. PCT/JP2004/016082	International filing date ( <i>day/month/year</i> ) 22.10.2004	Priority date ( <i>day/month/year</i> ) 26.12.2003	
International Patent Classification (IPC) or national classification and IPC INV. G11C11/56 G11C11/34 H01L45/00			
Applicant MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD. ET AL.			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 14 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p style="margin-left: 20px;">a. <input checked="" type="checkbox"/> <i>sent to the applicant and to the International Bureau</i> a total of 7 sheets, as follows:</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p style="margin-left: 20px;">b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input checked="" type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input checked="" type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand  18.10.2005		Date of completion of this report  30.03.2006	
Name and mailing address of the international preliminary examining authority:   European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized officer  Colling, P  Telephone No. +31 70 340-4429	



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International application No.  
PCT/JP2004/016082

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

**Description, Pages**

1-55 as originally filed

**Claims, Numbers**

1-9, 11-26, 28-31, 33-36, 38 as originally filed  
10, 27, 32, 37, 39 received on 20.10.2005 with letter of 18.10.2005

**Drawings, Sheets**

1/30-30/30 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

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**Box No. IV Lack of unity of invention**

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1. ☒ In response to the invitation to restrict or pay additional fees, the applicant has:
- ☒ restricted the claims.
  - ☒ paid additional fees.
  - ☐ paid additional fees under protest.
  - ☐ neither restricted nor paid additional fees.
2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is
- ☐ complied with.
  - ☒ not complied with for the following reasons:  
**see separate sheet**
4. Consequently, this report has been established in respect of the following parts of the international application:
- ☐ all parts.
  - ☒ the parts relating to claims Nos. 1-11,21-39 .

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	1-11,21-38
	No: Claims	39
Inventive step (IS)	Yes: Claims	4,23,25,29,31,36
	No: Claims	1-3,5-11,21,22,24,26-28,30,32-35,37-39
Industrial applicability (IA)	Yes: Claims	1-11,21-39
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

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**Box No. VI    Certain documents cited**

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1. Certain published documents (Rule 70.10)  
and / or
2. Non-written disclosures (Rule 70.9)  
**see separate sheet**

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.

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**Re Item IV.**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

- 1) claims 1-11,32-39:     Multibit memory device;
- 2) claims 12-20:         Memory device structure; and
- 3) claims 21-31:         Memory circuit with fewer read/write errors

The International Searching Authority considers that the present application contains 3 inventions. This observation is based on the following reasoning:

Reference is made to the following document D1:

D1:   ZHUANG W W ET AL: "Novel colossal magnetoresistive thin film nonvolatile resistance random access memory (RRAM)" INTERNATIONAL ELECTRON DEVICES MEETING 2002. IEDM. TECHNICAL DIGEST. SAN FRANCISCO, CA, DEC. 8 - 11, 2002, NEW YORK, NY : IEEE, US, 8 December 2002 (2002-12-08), pages 193-196, XP010626021 ISBN: 0-7803-7462-2.

Document D1 discloses (see memory array, figure 13, page 195, right hand column; the references in parentheses applying to this document) a memory device (a memory array) comprising a first variable resistor (first RRAM cell) connected between a first terminal (wordline GND) and a third terminal (bitline) having a resistance which changes in accordance with a polarity of a pulse voltage between the first terminal and the third terminal; and a second variable resistor (second RRAM cell) connected between the third terminal (same bitline) and a second terminal (wordline 0V) having a resistance which changes in a direction opposite to a direction of change of the first variable resistor in accordance with a polarity of a pulse voltage between the third terminal and the second terminal.

Hence all features of independent apparatus claim 1 are known from D1 and said claim

thus lacks novelty.

Dependent claim 2 and independent claim 12 share the following features:

a memory device comprising a (first) resistor having a resistance which changes in accordance with a polarity of a pulse voltage applied thereto.

These features are however known from prior art document D1 (see page 193, left-hand column, paragraph 2).

The special technical feature STF in the sense of Rule 13(2) PCT of claim 2 is thus constituted by:

the resistance value of the first variable resistor and the resistance value of the second variable resistor change in accordance with a first potential applied to two of the first terminal, second terminal and the third terminal and a second potential different from the first potential applied to the other terminal of the first terminal, the second terminal and the third terminal.

The problem to be solved by this feature could be said to be the provision of a multibit memory device (see description page 2, lines 10-25 of the present application).

Similarly independent claims 12 and 21 share the following features:

a memory device comprising a plurality of memory cells, each memory cell comprising a transistor connected to a variable resistor (layer) whose resistance value changes in response to a pulse voltage applied thereto.

These features are however also known from prior art document D1 (see figure 4)

The special technical feature STF in the sense of Rule 13(2) PCT of claim 12 is thus constituted by: an insulating layer formed over said transistor, said variable resistor film formed over the insulating layer.

The problem to be solved by this feature could be said to be the provision of a highly integrated memory cell with an increased degree of miniaturization (see description page 3, lines 1-20 of the present application).

Similarly independent claim 21 and dependent claim 2 share the following features:

a memory device comprising a variable resistor connected between a first and a second terminal whose resistance value changes in response to a pulse voltage applied between said terminals.

These features are however also known from prior art document D1 (see page 193, left-hand column, paragraph 2).

The special technical feature STF in the sense of Rule 13(2) PCT of independent claim 21 is thus constituted by:

a first memory block connected between a first node and a second node; a first block selecting transistor connected in series with the first memory block between the first node and the second node; and a second memory block connected between an interconnect node and a third node, the interconnect node connecting the first memory block and the first block-selecting transistor to each other, wherein each of the first and second memory blocks includes a plurality of memory cells connected in series, and each of the plurality of memory cells including a transistor coupled in parallel with the variable resistor between the first and second terminal.

The problem to be solved by this feature could be said to be the provision of a memory circuit with fewer errors in recording and reproduction  
(see description page 3, line 21 - page 4, line 25 of the present application).

The above analysis shows that there are no special technical features in the claimed 3 inventions, which are common. These features are not corresponding either, because they solve different, non related problems. Since common or corresponding STF's between the different inventions are missing, a technical relationship involving those features cannot be present  
and the different inventions are thus not linked by a single general inventive concept.

Hence the present application does not meet the requirements of Unity of invention as defined in Rule 13(1) PCT.

**Re Item V.**

**FIRST INVENTION: CLAIMS 1-11, 32-39**

1. The following further document is referred to in this communication:

D2 : US 2003/038301 A1 (MOORE JOHN) 27 February 2003 (2003-02-27); and

**2. The application does not meet the requirements of Article 6 PCT because:**

**2.1** The subject-matter of dependent claim 34 is redundant because, as far as it can be understood, said subject-matter is already included in parent claim 32.

**2.2** The expression "a second potential" in claim 7 is unclear because a first potential has not been defined in claim 7 itself or its parent claim.

**2.2** The expression "the first polarity" in claim 10 is undefined.

**3. INDEPENDENT APPARATUS CLAIM 39 (amended)**

The subject-matter of claim 39 is not new in the sense of Article 33(2) PCT and therefore does not meet the criteria of Article 33(1) PCT:

Document D2 discloses (see paragraphs [0021] - [0027] and figure 7; the references in parentheses applying to this document) a memory cell (dual cell common electrode programmable metallization (PCRAM) memory cell) suitable for storing at least one bit of data, comprising:

first variable resistance means (118) suitable for changing resistance in accordance with a polarity of a pulse voltage between a first terminal (source/drain of transistor 118<sub>AT</sub>) and a third terminal (common anode 110); and

second variable resistance means (120) suitable for changing resistance in a direction opposite to a direction of change of the first variable resistance means in accordance with a polarity of a pulse voltage between the third terminal (110) and a second terminal (source/drain of transistor 120<sub>AT</sub>)

(for PCRAM cells, an increase or decrease of the memory cell resistance value depends on the polarity of the applied voltage to the two electrode terminals (anode, cathode) of the cell).

Thus all features of independent apparatus claim 39 are already known from D2 and said claim thus lacks novelty (Article 33(2) PCT).

**4. INDEPENDENT APPARATUS CLAIM 1**

The subject-matter of claim 1 does not meet the criteria of Article 33(1) PCT, because it



does not involve an inventive step in the sense of Article 33(3) PCT:

Document D2, which is considered to represent the closest prior art document, discloses (see paragraphs [0021] - [0027] and figure 7; the references in parentheses applying to this document) a memory device (dual cell common electrode programmable metallization (PCRAM) memory device), comprising:

a first variable resistor connected (118) between a first terminal (source/drain of transistor 118<sub>AT</sub>) and a third terminal (common anode 110) having a resistance which changes in accordance with a polarity of a pulse voltage between the first terminal and the third terminal; and

a second variable resistor (120) connected between the third terminal (110) and a second terminal (source/drain of transistor 120<sub>AT</sub>) having a resistance which changes in accordance with a polarity of a pulse voltage between the third terminal and the second terminal (for programmable metallization cells, an increase or decrease of the memory cell resistance value depends on the polarity of the applied voltage to the two electrode terminals (anode, cathode) of the cell).

The subject-matter of claim 1 therefore differs from this known from D2 only in that **the second variable resistor changes resistance in a direction opposite to a direction of change of the first variable resistor**

This selection of a resistance change direction out of two possible directions can only be regarded as inventive, if it presents unexpected effects or properties in relation to the other direction. However, no such effects or properties are indicated in the application, both devices i.e. the memory device of the present application and the memory device of D2, being multibit memory devices.

Hence the subject-matter of claim 1 cannot be considered as inventive.

#### 5. INDEPENDENT METHOD CLAIMS 32 and 37 (amended)

The present application does not meet the criteria of Article 33(1) PCT, because the subject matter of independent method claims 32 and 37 does not involve an inventive step

in the sense of Article 33(3)PCT:

Independent method claims 32 and 37 claim a three terminal variable resistance memory cell writing/resetting method and reading method respectively, whereby different potential combinations are applied to the terminals of said memory cell. These methods are however equally applicable to the three terminal memory cell described in D2, figure 7 with the same result and the proposed methods in independent claims 32 and 37 thus cannot be considered as inventive (Article 33(3) PCT).

**6. DEPENDENT CLAIMS 2-3, 5-11, 33-35, 38**

As far as it can be understood, dependent claims 2-3, 5-11, 33-35, and 38 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT).

**7. DEPENDENT CLAIMS 4 and 36**

Presently it appears that the combination of the features of dependent claims 4 and the combination of the features of dependent claim 36 are neither known from, nor rendered obvious by, the available prior art. The reasons are that none of the cited prior art documents discloses nor suggests a memory cell comprising first and second variable resistance means arranged and biased as described in claims 4 or 36 thereby allowing multibit data storage.

**THIRD INVENTION: CLAIMS 21-31**

1. The following further documents are referred to in this communication:

D4: WO-A2-02 19337 (MOTOROLA INC.) 07 MARCH 2002 (2002-03-07);  
D5: US-B1-6 226 197 (NAOKI NISHIMURA) 01 MAY 2001 (2001-05-01);  
D6: US-A-5 969990 (KENSHIRO ARASE) 19 OCTOBER 1999 (1999-10-19).

**2. INDEPENDENT APPARATUS CLAIM 21**

The subject-matter of claim 21 does not meet the criteria of Article 33(1) PCT, because it

does not involve an inventive step in the sense of Article 33(3) PCT.

Document D4, which is considered to represent the closest prior art document, discloses (see page 7, line 26 - page 9, line 14 and figure 3; the references in parentheses applying to this document)

a memory circuit (magnetic tunnel junction random access memory 15) comprising:

a first memory block (16) connected between a first node (ground connection of block 16) and a second node (19);

a first block-selecting transistor (28) connected in series with the first memory block between the first node and the second node; and

a second memory block (17) connected between the second node (19) and a third node (ground connection of block 17);

wherein each of the first and second memory blocks includes a plurality of memory cells (18) connected in series, and

each of the plurality of memory cells includes

a variable resistor (magnetic tunnel junction 26) connected between a first terminal and a second terminal and whose resistance value changes in response to a pulse voltage applied between the first terminal and the second terminal, and

a transistor (27) connected in parallel with the variable resistor (magnetic tunnel junction 26) between the first terminal and the second terminal.

**The subject-matter of claim 21 therefore differs from D4 in that said second memory block is connected between an interconnect node and a third node, the interconnect node connecting the first memory block and the first block-selecting transistor to each other (whereas in D4 a second block-selecting transistor is coupled between the second memory block and the second node (19)).**

The problem to be solved by the present invention may therefore be regarded as the provision of a low disturb memory device using a reduced chip area.

A memory circuit wherein more than one memory block is connected through a block-selecting transistor is however known from D6 (see memory blocks NAND1a and NAND2a connected by block-selecting transistor TG1a to bitline MBLa in figure 2) and the skilled person, without the exercise of inventive skill, would thus consider to connect said second memory block at said interconnect node, in order to solve the problem posed.

Hence independent claim 21 cannot be considered to involve an inventive step.

Claim 21 does not explicitly claim that the first/second node is distinct from the third node and does not claim that different potentials are applied to the first/second node and the third node.

### 3. INDEPENDENT APPARATUS CLAIM 27 (amended)

The subject-matter of claim 27 does not meet the criteria of Article 33(1) PCT, because it does not involve an inventive step in the sense of Article 33(3) PCT.

Document D4, which is considered to represent the closest prior art document, discloses (see page 7, line 26 - page 9, line 14 and figure 3; the references in parentheses applying to this document)

a memory circuit **array having more than one column** (magnetic tunnel junction random access memory 15) comprising:

a first memory block (16) connected between a node receiving a fixed power supply (ground connection of block 16) and a first bit line (19);

a first block-selecting transistor (28) connected in series with the first memory block between the first bit line and the node;

a second memory block (16' in further column) connected between the node receiving the fixed power supply (ground connection of block 16') and a second bit line (19' in further column) different from the first bit line (19);

a second block-selecting transistor (28' in further column) connected in series with the second memory block between the second bit line and the node,

wherein each of the first and second memory blocks includes a plurality of memory cells (18) connected in series, and

each of the plurality of memory cells includes

a variable resistor (magnetic tunnel junction 26) connected between a first terminal and a second terminal and whose resistance value changes in response to a pulse voltage applied between the first terminal and the second terminal, and

a transistor (27) connected in parallel with the variable resistor (magnetic tunnel junction 26) between the first terminal and the second terminal.

**Thus the subject-matter of claim 27 differs from a memory array of D4 only in that said power supply is variable (whereas in D4 said power supply is constant i.e. ground).**

This feature however has to be considered as merely one of several straightforward possibilities from which the skilled person would select, in accordance with circumstances, without the exercise of any inventive skill.

Hence independent claim 27 cannot be considered to involve an inventive step.

#### **4. DEPENDENT CLAIMS 22, 24, 26, 28, 30**

Dependent claims 22-24, 26 and 28-30 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT) (see documents cited in search report, especially D5, column 10, line 40 - column 11, line 18 and figures 15 and 16).

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**5. DEPENDENT CLAIMS 23, 25 and 29, 31**

It presently appears that the subject-matter of dependent claims 23, 29 and dependent claims 25, 31 fulfills the requirements of Article 33(1) PCT, because none of the cited prior art documents discloses nor suggests writing methods or reading methods respectively for a memory circuit wherein coordinated voltages are applied between complementary memory blocks.

6. Some of the features in dependent apparatus claims 22-25 and 28-31 relate to a method for reading and a method for writing a memory device rather than clearly defining the memory in terms of its technical features. The intended limitations are therefore not clear from these claims, contrary to the requirements of Article 6 PCT.

**Re Item VI**

**Certain documents cited**

**Certain published documents**

Application No Patent No	Publication date (day/month/year)	Filing date (day/month/year)	Priority date (valid claim) (day/month/year)
EP 1 426 966 A2	09.06.2004	04.12.2003	05.12.2002
EP 1 455 363 A1	08.09.2004	03.03.2004	06.03.2003